INTELLIGENT LOAD DISTRIBUTION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a system for determining load distribution on a vehicle.

State and federal laws impose load limits on trucks. Limits exist on maximum weight, weight over an axle, and weight over a tandem axle. These limits vary from state to state, requiring a truck driver to know whether he is in compliance with these limits as he crosses each state line. In the event a load exceeds these limits, the truck driver must either reduce the load or redistribute the load over the truck to conform to regulatory requirements. Failure to comply with such limits can lead to the imposition of fines or other penalties.

Additionally, the distribution of load over a truck significantly alters its handling, performance, and fuel efficiency. Braking, acceleration, turning, as well as operational safety of the vehicle are all affected by load distribution. Improper loading of a truck not only reduces vehicle performance but also increases the risk of an accident.

Currently, load distribution on a truck is determined by employing rudimentary methods such as weighing the vehicle on a load scale. Typically, a truck is driven onto a platform with load cells. These load cells send out electronic signals to junction boxes, which then sum all of the signals into one signal so that the signal can be read by a load indicator. The load of each axle can be determined either by derivation from the whole weight of the truck or by weighing the axles of the truck individually.

On board systems for weighing load also exist. One such system measures the load on a truck directly by reading load cells on the truck bed. Another system measures load indirectly by relating load to air pressure on the truck's suspension. Such systems provide the truck driver with a reading of load distribution only.

While these foregoing methods provide basic information about the distribution of weight over a truck, they do not provide information on how to optimize the distribution of weight on a truck to comply with load limits or to enhance vehicle performance. To determine compliance with load limits, a truck driver must manually compare load distribution values with state and federal weight limit tables. Because these limits vary from jurisdiction to jurisdiction as well as by truck type and truck characteristic, a truck driver must maintain updated tables for each jurisdiction and compare these tables with his load distribution for each state of operation.

Moreover, the measurements offered by these foregoing methods of determining load distribution are not integrated or analyzed with other vehicle characteristics that affect vehicle maneuverability and handling such as tire pressure, axle position, or trailer height. Load distribution is accordingly not optimized for performance.

A need therefore exists for a system to provide information to optimize the distribution of load on a truck not only to comply with state and federal law but also to optimize vehicle performance.

SUMMARY OF THE INVENTION

The present invention relates to a system for optimizing load distribution on a truck or other vehicle. A computer or other evaluation unit reads the information from at least one load sensor, measuring the load of the truck and its distribution. The computer then evaluates the information with a database compiling information on optimizing load distribution for vehicle performance as well as for compliance with state and federal law.

Existing on board load sensors are used to determine load over portions of the vehicle. A sensor may determine load over a trailer axle, a tractor axle and a truck kingpin. Another load sensor may read the brake bias on the truck and trailer's brakes. All of these sensors provide information to the computer for analysis with load optimizing information.

Load information can be further evaluated with information concerning the vehicle's characteristics. This information includes dimensions of the truck, the truck's load capacity, the truck's power train characteristics, and other vehicle specific information. In particular, the load sensors can be used in conjunction with position sensors, which determine the position of the tractor's axles to the trailer's axles, and the position of its individual axles on the trailer.

With information from load sensors, position sensors, and the vehicle's characteristics, a computer may then determine the optimal distribution of load on a vehicle to comply with state and federal load limits and provide best vehicle performance for a given load. Information for optimizing load distribution is then communicated to the driver by a display, which is interactive, allowing the driver to input and retrieve information for load optimization. Both the display and the system are preferably on board the truck, permitting the truck driver to optimize load for each state he enters to comply with load limit regulations as well as to ensure best vehicle performance for a given load. In this way, a truck driver will not only have information on how load is distributed but on how to optimize the distribution of load on his truck.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

Figure 1 shows a top view of a truck employing an embodiment of the invention, including evaluation unit and load sensors.

Figure 2 shows a schematic of information provided to the evaluation unit.

Figure 3 shows a side view of an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 presents an embodiment of the invention. As known in the prior art, systems exist that measure the distribution of load across a vehicle such as truck 20, as seen in Figure 1. These systems employ at least one or a plurality of load sensors 24A-J to determine the load over axles 28A-E as well as kingpin 32, the mechanical pivoting pin link between tractor and trailer. Such sensors include load cells, piezo electric film sensors, and strain gauges. Pressure sensors measuring load on a vehicle's air suspension can also function as load sensors. Readings from load sensors 24A-J are then used to determine load distribution across truck 20, tractor 38 and trailer 40.

While readings from load sensors 24A-J provide basic information concerning load distribution, such as weight over axles 28A-E or even total weight of truck 20, a truck driver must determine for himself whether his load is in compliance with state and federal law load limits or whether his load is distributed in a manner that minimizes the load's effect on vehicle performance and safety. For a truck driver driving across numerous jurisdictions, the truck driver must maintain updated regulations and check compliance for each state entered. Additionally, in the event of the addition or redistribution of load, the truck driver must not only determine whether the load is in

compliance with load limits but must attempt himself to configure his load to optimize vehicle performance. Current systems fail to perform these functions for the truck driver.

In the present invention, evaluation unit 36 automatically provides the truck driver with a determination of how load distribution would be optimized for compliance with state and federal limits as well as for performance and operational safety of the vehicle. Evaluation unit 36 communicates with load sensors 24A-J and evaluates the signal or information from these sensors with load optimization data stored in memory unit within evaluation unit 36. Evaluation unit 36 determines tractor axle loads from load sensors 24A and 24F (axle 28A), 24B and 24G (axle 28B), and 24C and 24H (axle 28C), and trailer axle loads from load sensors 24D and 24I (axle 28D) and 24E and 24J (axle 28E). Additionally, loading at the truck's kingpin 28C is determined and analyzed.

Figure 2 illustrates types of load optimization data to be evaluated by evaluation unit 36. Static vehicle characteristic information such as tractor and trailer length, the empty weight of the vehicle, ride height (nominal height of suspension measured from axle to frame), and vehicle load capacity are stored and processed with information from load sensors 24A-J to optimize load distribution. Information from truck 20's power train such as engine and transmission data may also be stored in memory unit within evaluation unit 36 for optimizing vehicle performance and handling.

Dynamic features of truck 20 are also monitored and evaluated. Trailer ride height, and kingpin to axle distances are a few of the dynamic inputs that are examined. A person skilled in the art would know a number of other dynamic as well as static features that may be used to monitor and evaluate load distribution.

As seen in Figure 3, commercially available position sensors measure distances between components of truck 20. Position sensors 44A-E and 48 measure axle 28A, B, C, D, E to kingpin distances, for example the distance between 44A (axle) and 48 (kingpin). Position sensors may also, as known, monitor the position of suspension member 50, the distance between axle and frame. These distances are adjustable by many components on trucks and tankers, and factor importantly in determining optimal load distribution on truck 20, tractor 38 and trailer 40. Evaluation unit 36 monitors all of these distances.

Once evaluation unit 36 assesses the foregoing dynamic and static features of truck 20, evaluation unit 36 then evaluates this data with load limit information and performance information stored in memory unit of evaluation unit 36. Load limit information comprises a database of compiled state and federal load regulations. Vehicle performance information comprises a database of instructions to improve vehicle handling and maneuvering based on load distribution. From a comparison of this information, evaluation unit 36 arrives at the optimal load distribution to comply with load limits or to enhance vehicle performance and safety.

Referring to Figure 3, display 52 provides instruction to the operator to optimize load distribution. Display 52 may be a general user interface 56 to allow driver to query or respond to queries of evaluation unit 36. The algorithms to perform these calculations are well within the skill of the worker in the art. Display 52, general user interface 56, and evaluation unit 36 can all be integrated into the cab of the tractor 36 or remote to truck 20 or even hand-held.

The invention allows the truck driver to readily optimize his vehicle for performance and compliance with load limits. For example, a driver loads at a loading dock with trailer 40 in the farthest rearward position. After loading, the driver examines display 52 and queries evaluation unit 36 to optimize truck 20 for city driving. Evaluation unit 36 reads signals from load sensors 24A-24J and position sensors 44A-E, 48, and 50. After reading and evaluating these sensors with load optimization data, display 52 then provides the truck driver with the optimal position of trailer 40 for the given load distribution for city driving. Display 52 also warns truck driver of any axle overload conditions or state and federal load limit violations. Additionally, optimal tire pressure and braking ratio is also displayed. After each delivery of load from the truck, the driver can continue to query evaluation unit 36 to configure truck 20 for optimal performance by repositioning load and/or repositioning components of truck 20.

The invention allows drivers to avoid load limit violations and improve vehicle performance for any given load. The system electronically performs this function by evaluating load distribution with a database of vehicle performance information and a database of state and federal regulations. This system replaces the manual process of

checking load distribution against tables of load limits as well as the truck driver's best estimate on optimizing the vehicle for performance. Improved vehicle handling and safety, cargo efficiency and better tire and brake wear will result.

The aforementioned description is exemplary rather then limiting. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed. However, one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. Hence, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For this reason the following claims should be studied to determine the true scope and content of this invention.